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# INVESTIGATION

INTO THE PROBLEMS AND FAILURES
ON THE SYSTEM INSTALLED AT

# WESTAR MINES

Prepared for

## CANMET

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Final Report
by

## CONSPEC

Controls Limited

# INVESTIGATION INTO THE PROBLEMS AND FAILURES ON THE SYSTEM

# INSTALLED AT WESTAR MINES

BY

CONSPEC CONTROLS LTD.

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the auspices of the Canada Centre for Mineral
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# INTRODUCTION

The CANMET Coal Research Laboratory located in Calgary purchased a Conspec Senturion 200 mine monitoring system in November 1982, under Canmet project number C015-C55-1. The system supplied (as per the contract) was the then standard mine monitoring system produced by Conspec, but was modified to be intrinsically safe for use in coal-mines. Certification of the system by CANMET was obtained in November, 1982, (Certification No. 474).

Between November, 1982 and July, 1983 the system was run in the Canmet Calgary Laboratory, to allow the Canmet personnel to familiarize themselves with the equipment. No significant problems with the system were noted during this time.

In July, 1983 this system was moved to the Westar Hydraulic Mine loacated in Sparwood, British Columbia. Because of some unavoidable delays at the mine-site the communication cables for the system could not be installed until December, 1983. It may be noted that the installation of the communication cables were carried out by Westar personnel.

In January,1984 a Conspec representative commissioned the system. Within a week of system commissioning the first failures or problems related to the system monitoring were reported. From this time onward there were numerous phone calls between the personnel at Westar, Canmet personnel in Calgary and Conspec in Toronto. In July, 1984 a representative from Conspec was sent to the mine-site with the objective of fixing up the system and identifying the problems.

Within days following this visit, the system stopped working completely. As reported by Westar this was as a result of a suspected act of sabotage on the system. This also coincided with the annual holiday period and as such no remedial action could be taken at that time. After the holiday period there was a change in the key personnel operating the system at Westar. This resulted in a second round of lengthy telephone conversations to assist the Westar personnel in re-commissioning the system. A number of disruptions and breaks in the communication cables also delayed the rehabilitation process significantly. Eventually Canmet decided to issue this contract.

The terms of reference and the work statement for this contract is included in Appendix "A". In short, the main purpose in this contract is to investigate the problems associated with the installation and operation of this system at Westar mine and make recommendations so as to assure uninterrupted operation.

## HISTORY OF SYSTEM FAILURES AND PROBLEMS REPORTED.

A brief description of the system will help in identifying the cause and the nature of the problem. The system has been discussed in full in our earlier report R1081 (June, 1983).

The basic system supplied by Conspec consisted of the following major hardware components:-

a) The Central Station comprising of
   i. A Central Processing Unit c/w power supply.
   ii. An Operator's Video Terminal.
   iii. Printer devices for hardcopy output.
   iv. An Uninterruptible Power Supply.

b) Communication Hardware which comprises of
   i. Modem units for communication
   ii. Remote Intrinsically Safe Trunk Driver Stations.

c) Communication and Accessor Trunk Cables.

d) Sensors, comprising of
   i. Carbon Monoxide (CO) sensors
   ii. Methane ($CH_4$) sensors.
   iii. Air Velocity sensors.

The following paragraphs discusses the problems and/or failures experienced by Westar and Canmet personnel with particular reference to the components referred to above.

### 2.1 CENTRAL STATION HARDWARE

#### 2.1.1 Central Processing Unit

This part of the system operated without any problems over the two-year period. No failures were noted. This clearly established the stability and reliability of the processing unit. The CPU was completely designed and fabricated by Conspec Controls.

#### 2.1.2 OPERATOR'S VIDEO TERMINAL

The terminal used is a Televideo 950 terminal. During the months following system installation at the mine site there was a gradual deterioration of the video picture brigthness. The picture eventually disappeared in October, 1984. At this point the unit was returned to Conspec for repairs. It was found that the power supply within the unit had failed. The cause of failure being noted as a component failure.

### 2.1.3 PRINTER DEVICES

No problems or failures were reported during the period under review and both the printers performed satisfactorily.

### 2.1.4 UNINTERRUPTIBLE POWER SUPPLY

In January, 1984 when Conspec started up the system, it was noted that the AC power available at the mine site was outside of the recommended operating limits specified by Conspec for the central station. This accounted for occasional system starting up difficulties and mysterious "software crashes" that occured. On advice from Conspec, CANMET purchased a SOLA Constant Voltage Transformer/Isolator. No further central station problems were experienced after the addition of this device to the system.

The uninterruptible power supply (UPS) supplied with the system is a 500 KVA unit capable of sustaining the central station for a period of four hours. Following a number of tests conducted by Westar (June and July, 1984), it was found that the UPS did not switch over properly, i.e. it caused a processor failure on switching. During the visit to the mine-site by Conspec in July, 1984, it was determined that the battery charger portion of the UPS was faulty, since the charger was not switching in correctly. The unit was subsequently returned to Conspec for repair.

The unit was then examined by the UPS supplier (Pribusin Inc), and it was found that a number of connectors and screws within the unit were loose. This was attributed to vibration that may have occured during the shipping of the UPS, or during the installation. No defects other than this was found.

The present UPS units being shipped by Conspec have additional lock-washers and "loctite" is added to prevent this from happening in the future. Because of mine closure UPS could not be tested so far at Westar operations.

## 2.2 COMMUNICATION HARDWARE

### 2.2.1 Remote Intrinsically-Safe(IS) Trunk Driver Stations

The original system installation consisted of a single IS Trunk Driver Station. A second station was added, and then a third station for use at the central location in the Westar engineering office was purchased. This station was not housed in a flameproof enclosure, since it was not intended to be installed underground. Electrically it was identical to the remaining two stations.

The original mine installation had the two units connected underground. However the communication link to the second unit was run primarily along the outside of the mine. The total length of the communication line was approximately five miles, which is almost at the operating limit of the devices supplied. A maximum limit of five and one-half miles is specified in the manual.

Immediately following system installation, there were numerous complaints regarding the communication messages, and several attempts were made by Westar to adjust the communication modems. After approximately two months trial and error there appeared to be reasonable communications, that is the system did not report any frequent failures. This was due to increased familiarity with the system, and adopting the correct procedure for adjusting the communication modems by the Westar operators.

The data generated by the system was then analyzed by Canmet and several odd or spurious readings noted. Conspec was then informed of the problem and it was determined that there was either a communication problem, or a sensor problem. After a number of telephone calls, and when all attempts to solve the problem locally failed, a Conspec engineer was called to the site in July, 1984.

Two solutions were offered by Conspec during the July visit:

a) A software filter was added to weed out the spurious readings,
b) The system modems were re-adjusted.

During the three day visit to the site in July by Conspec, the system was allowed to run without the software filter, in order to ascertain whether the communication modem adjustment alone was sufficient to correct the problem. No abnormal readings, or communication failures were reported during this time. However, within two days after this visit the system was found to be completely inoperative.

A full examination by Canmet and Westar personnel at that time indicated a number of problems, such as severed wiring in the IS Trunk drivers, and incorrectly set switches. These were repaired by Canmet, with the assistance from Westar personnel. During this process Conspec provided advice over the telephone.

The communication problem re-occured once again, and Conspec was then commissioned to determine the cause of this failure. In the opinion of the author, the primary cause of this failure is incorrect adjustment of the communication modem. Unfortunately this cannot be confirmed, since on arrival at the mine site in November, 1984 to determine the cause of the problem, it was found that all underground hardware were being relocated. The trunk driver stations were now being installed closer to each other and the total length of the communication line was substantially being reduced to a total length of less than three miles.

The third IS Trunk driver which was located at the central station was not properly integrated into the system, as observed during this investigative visit. Previous attempts by Westar personnel to integrate this station were not succesful. The parts from this trunk driver station were mostly used as spares for the other two stations installed underground.

This third unit was integrated into the system by Conspec during the November, 1984 visit.

Apart from the communication modem adjustment problem, the only hardware failure experienced was a defective electronic card (Modem interface card), which was repaired by Conspec during the November visit.

## 2.3 COMMUNICATION AND ACCESSOR CABLE

### 2.3.1 Communication Cable

The system uses a single twisted wire pair for communication between the central station and each remote IS trunk driver. The signal on this cable is a Phase-Shift Keyed signal (PSK) which has a potential of less than 1.00 Volt RMS. Because of this low signal level Conspec recommends that wherever possible this cable be kept as far as possible away from any high voltage or AC power carrying conductors. This has been adequately emphasized in the manual.

One of the areas of concern with regard to the communication failures experienced by Westar was this particular factor referred earlier. It was thought that the communication cables were possibly too close to the power lines. This proved to be incorrect. During the inspection of the system by Conspec in November, 1984 it was found that Westar had complied with this requirement, as best they could within the constraints of the mine.

The choice of location of the IS Trunk Driver for the new configuration was however contrary to this, in that it was placed inside a power sub-station underground. On the advice of Conspec the trunk driver was moved to another location.

### 2.3.2 ACCESSOR TRUNK CABLE

So far, the trunk cable provided no significant problem. There was however one operational problem identified. The original system required that the power be shut off during the addition or removal of a sensor from the trunk cable. Because of the difficulties in obtaining the services of qualified electricians underground to turn the power switch on and off (as per mine regulations), this caused some difficulties. During the iinitial months of operation, the sensors were added and removed with the trunk driver station powered. This resulted in the

protective fuses being blown on the IS power supply in the trunk driver station.

To overcome this particular problem, Conspec supplied isolation switches for the trunk. The procedure for adding and removing sensors from the trunk now requires that this isolation switch be disconnected. Since the trunk is intrinsically-safe a qualified electrician is no longer required to carry out this function.

## 2.4 SENSORS

### 2.4.1 CARBON MOXIDE SENSORS

There are two types of CO sensors that were supplied. These were a) Energetic Sciences "Ecolyzer CO" (Diffusion type) and b) Mine Safety Appliances "(MSA) CO" (Diffusion type).

There were no failures reported , except for the sensor heads which needed replacement from time to time. This was normal since the sensor heads are a disposable item with an expected lifetime of 12 months. The MSA unit, however, had to be returned to the manufacturer for cell replacement, since they are not readily available as stock items.

### 2.4.2 METHANE SENSORS

Two types of methane sensors were used with this system which includes a total of three J-TEC Instrument methanometers and a SIEGER (UK) BM1- Methanometer.

At the time of the investigation it was found that the BM1 unit was never installed underground, primarily because of its size and weight, compared to the J-TEC. The BM1 unit is considerably heavier, and Westar found the sensor to be rather large and bulky for use in its underground mine. At the time of the investigation the unit was still functional. At this time it was recommended to Westar that the unit be installed underground.

At the time of the site investigation, two of the three J-Tec units were found to have defective cells. The reasons for the cell failures are numerous and in the opinion of the author are probably due to their frequent relocation underground and associated unsafe handling, or inadvertant cell poisoning.

The J-Tec methanometers were also found to produce faulty or erratic readings during the earlier months of the installation. It appears that this faulty behaviour was caused by a reduction in the sensor electronics capacitance. Conspec has since modified the instruments (August, 1984), and has obtained IS approval from CANMET. The author feels that this modification has corrected the problem as indicated by the results obtained in December, 1984.

### 2.4.3 AIR VELOCITY SENSORS

The air-velocity sensors supplied were J-TEC vortex shedding type instruments. These units were found to produce faulty readings when installed. It appears that this faulty behaviour was caused by a reduction in the capacitance of the sensor electronics, in order to comply with Canmet IS Approval requirements. The circuitry was found to be extremely susceptible to noise, because of this reduction, and the output had a tendency to latch itself onto the full-scale value.

Conspec modified the instrument circuitry, and re-submitted the design for IS Approval. This was received, and the units were then modified. The author feels that this modification has corrected the problem as indicated by the results obtained in December, 1984.

## 2.5 SYSTEM SOFTWARE

The software supplied with the Senturion 200 system did not appear to have failed. There were, however, some problems in the interpretation of the Shift Reports generated by the system.

The software supplied with this particular system contains a shift Report generator package. The Shift Report is printed at the end of each shift. The following information and data is contained in the report :-

( Refer to fig 4-1 to 4-6)

i. The title, including the time and date.

ii. The sensor description. This comprises of a three-digit number followed by an 18-character descriptor.

iii. The average value of the sensor over the shift period. This value is the arithmetic average of samples taken once every minute over the shift period.

iv. The highest instantaneous sensor reading measured during the shift, and the time of its occurrence. Only the hours and minutes of this event are printed.

v. The lowest instantaneous sensor reading measured during the shift, and the time of its occurrence. Only the hours and minutes of this event are printed.

vi. Finally, the number of one-minute samples used to calculate the average is also printed.

The Senturion 200 system installed has a scan time of one second. That is, all the sensors values are updated once every second. Each time a sensor is "scanned" or read, the new reading is stored in the processor's memory.

In order to calculate the average the system selects

one of the sixty samples obtained during the one-minute period. This selection is based on the one that is most current at the time the system clock makes the one minute "tick". Every 60th sample will therefore be chosen.

In order to determine the highest and lowest readings attained during a shift, the software compares each of the samples (once every second), against the current highest and lowest values reached, to determine if a new peak or low has been reached. At the beginning of the shift, the software sets the high and low values equal to the sensor value at the beginning of the shift, and also initializes the times of occurrence to the shift start time.

If a sensor has a reasonably constant value throughout the shift, then the three values printed (ie. average, high and low) will be close in magnitude. It is also likely that the time of occurrence for the high and low values will be close to the shift start times. This is the case since if the same "highest" (or "lowest") readings are attained several times during the shift, only the first time at which it occured will be logged by the software. This is because it is then searching for a value "higher" (or "lower") than the previous limit reached.

If a sensor is disconnected, or if the communications to the sensor is lost, then the readings for that sensor will not be updated. The last recorded value in the system's memory is then used for display in the report. The values produced for this sensor will therefore be constant throughout the shift. In this case the average, high and low are all identical. The time of occurrence of the high and low will be the start time of the shift. This condition is shown in Fig 4-3 (Point No. 1)

The J-Tec airflow sensor provides an analog output. This output oscillates around the average airflow at the time of measurement. This is because of the extremely fast response time of the sensor. Since the sensor is actually counting the number of vortices generated by the airstream while passing a fixed diameter post in the sensor head, any additional vortices in the airstream due to turbulence will distort the instantaneous reading. While the instatntaneous reading from the sensor will likely be incorrect, the average value over a finite period of time will be correct. Because of the rapid speed with which this output changes, it is possible that over a 60-second (1-minute) period, that both the highest and lowest recorded values for a given shift may occur. This is shown in Fig 4-4 (Point No. 3).

JUN 25, 1984 16:00:00 SHIFT REPORT

REPORT NO. 3 DAY=25

| | DESCRIPTOR | AVERAGE | UNITS | HIGH | TIME | LOW | TIME |
|---|---|---|---|---|---|---|---|
| 1 | CH4-6007-1 | 0.0000000 | I | 0.0000000 | 12:00 | 0.0000000 | 12:00 |
| 2 | CH4-6008-10 | 0.1960000 | I | 4.9196000 | 15:37 | 0.1960000 | 12:00 |
| 3 | CH4-PORTAL-3 | 0.0392000 | I | 0.1764000 | 14:03 | 0.0000000 | 13:10 |
| 4 | CO-PORTAL-64 | 2.3520000 | PPM | 2.5480000 | 12:00 | 2.1560000 | 12:00 |
| 5 | AIRFLOW-6007-14 | 637.20000 | F.P.M. | 755.20000 | 14:46 | 495.60000 | 14:14 |
| 6 | AIRFLOW-6008-11 | 413.00000 | F.P.M. | 519.20000 | 13:51 | 330.40000 | 12:45 |
| 7 | AIRFLOW-PORTAL-15 | 59.000000 | F.P.M. | 118.00000 | 12:12 | 35.400000 | 12:00 |
| | NO. SAMPLES USED | 240 | | | | | |

FIGURE 4-1

DEC 21. 1984 07:57:33 SHIFT REPORT

REPORT NO. REQ DAY=21

| | DESCRIPTOR | AVERAGE | UNITS | HIGH | TIME | LOW | TIME |
|---|---|---|---|---|---|---|---|
| 1 | AIR-6008-12.5-11 | 44280. | CFM | 52260. | 07:03 | 36300. | 07:25 |
| 2 | CO-6007-16X/C-7 | 4.6812 | PPM | 4.98 | 07:15 | 4.2828 | 07:27 |
| 3 | AIR-6007-6-14 | 5904. | CFM | 6856. | 07:00 | 4952. | 07:13 |
| 4 | CH4-6007-6-10 | 0.2744 | I | 0.3136 | 07:29 | 0.2744 | 07:00 |
| 5 | CO-MSA-6007-6-12 | 3.332 | PPM | 3.528 | 07:15 | 3.136 | 07:00 |
| | NO. SAMPLES USED | 57 | | | | | |

FIGURE 4-2

DEC 23. 1984 23:00:00 SHIFT REPORT

REPORT NO. 3 DAY=23

| | DESCRIPTOR | AVERAGE | UNITS | HIGH | TIME | LOW | TIME |
|---|---|---|---|---|---|---|---|
| 1 | AIR-6008-12.5-11 | 344860. | CFM | 344860. | 15:00 | 344860. | 15:00 |
| 2 | CO-6007-16X/C-7 | 4.482 | PPM | 5.1792 | 19:10 | 3.486 | 17:21 |
| 3 | AIR-6007-6-14 | | | 12. | 19:12 | 4952. | 15:27 |
| 4 | CH4-6007-6-10 | 0.294 | I | 0.294 | 15:00 | 0.2744 | 15:00 |
| 5 | CO-MSA-6007-6-12 | 3.332 | PPM | 4.312 | 19:16 | 2.94 | 15:00 |
| | NO. SAMPLES USED | 480 | | | | | |

FIGURE 4-3

DEC 6, 1984 08:21:56 [illegible] REPORT

REPORT NO. SEQ DAY-DA

| | DESCRIPTOR | AVERAGE | UNITS | HIGH | TIME | LOW | TIME |
|---|---|---|---|---|---|---|---|
| 1 | AIR-6008-12.5-11 | 34970. | CFM | 41620. | 07:56 | 28320. | 07:06 |
| 2 | | 0.00 | | 0.00 | 07:00 | 0.00 | 07:00 |
| 3 | AIR-6007-6-15 | 4000. | CFM | 4952. | 07:00 | 4000. | 07:00 |
| 4 | CH4-6007-6-10 | 0.294 | I | 0.3136 | 07:00 | 0.294 | 07:00 |
| 5 | CO-MSA-6007-6-12 | 2.548 | PPM | 3.136 | 07:27 | 2.548 | 07:00 |
| | NO. SAMPLES USED | 81 | | | | | |

FIGURE 4-4

| | 3 | 4 | 5 | 1 |
|---|---|---|---|---|
| | CFM | | PPM | |
| | | I | | CFM |
| 08:26:00 | 4000. | | 2.548 | |
| | | 0.3136 | | 38960. |
| 08:41:00 | 4952. | | 2.548 | |
| | | 0.3136 | | 32310. |
| 00:01:00 | 4000. | | 2.744 | |
| | | 0.3136 | | 36300. |
| 09:08:00 | 4000. | | 3.724 | |
| | | 0.3136 | | 34970. |
| 10:49:00 | 4000. | | 3.724 | |
| | | 0.3136 | | 33640. |
| 10:50:00 | 4952. | | 3.528 | |
| | | 0.3136 | | 34970. |
| 10:51:00 | 4952. | | 3.332 | |
| | | 0.3136 | | 34970. |
| 11:06:00 | 4952. | | 3.528 | |
| | | 0.3136 | | 33640. |

SAMPE TREND LOG

FIGURE 4-5

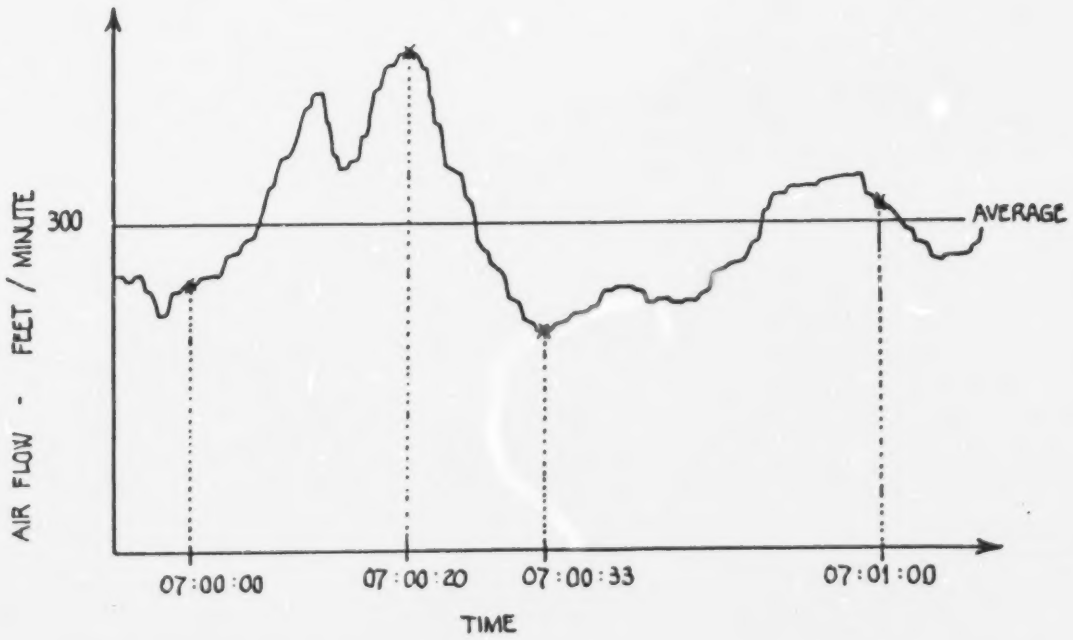



FIGURE 4.6 : SAMPLE AIRFLOW SENSOR OUTPUT.

From this sample, it is evident that the time of occurence of the highest and lowest values attained during a shift, is within the same minute.

## CAUSES OF SYSTEM FAILURES

The causes of the major problems and failures encountered are summarized below.

a) A number of design problems appear to have existed in the original system supplied. These problems and the necessary "fixes" are described below:-

i. The original system required that power be shut off during the addition or removal of sensors from the system. Because of the difficulties in obtaining the services of qualified electricians underground to turn the power on and off (a mine regulation) this was causing some difficulty. The addition of trunk isolation switches eliminated this problem. These switches are now supplied as a standard part of the system.

ii. The J-TEC air flow instrument, as well as the methane instruments contained too little capacitance for the electronics to operate reliably. The design was modified and the instruments were re-submitted for approval to CANMET. Approval for both of these instruments have been obtained, and future installations will use this type. Extended underground text will confirm their stability and reliability.

iii. The problem of communication modem adjustment came into focus by this installation. Unfortunately there are no simple rules for this procedure as stated in the manual. An iterative procedure based on measured responses and observations as to the system's behaviour on site should be carried out. It is necessary to perform this adjustment whenever a new trunk driver station is added, or if an existing trunk driver station is relocated. If the new location is within 1000 feet of the old location then adjustment is not necessary. In the revised Operators Manual this adjustment procedure is clearly emphasised and explained.

This procedure is normally carried out by Conspec personnel at system start-up. It is at this time that training in the set-up of the communication modems for the customer's installation is normally provided. It should be noted that the addition of sensors or extension of the trunk cable does not require any adjustments.

In the case of Westar the basic problem appears to be the fact that the system was continually being reconfigured, and the system being re-adjusted. Either of these conditions would lead eventually to incorrect communication modem settings. This could also be the source of a number of malfunctions at the Westar mine.

b) Premature component failures also accounted for some of the operational problems. The following falls into this category:-

i. The failure of the Operators Video Terminal.
ii. The malfunctioning of the Uninterruptible power supply.

c) Lack of training in the use and operation of the system by Westar personnel. In the opinion of the author adequate training is the single most important requirement for successful and problem-free operation. A longer training period of two to three weeks may prove beneficial.

d) Frequent system changing and adjustment is another cause of problems. From the author's experience over a number of installations of the Conspec hardware, it is evident that once the system is installed and initially adjusted, no further adjustments or alterations are required. The only time problems are reported is during the time when the system is being re-configured or changes are made to the system. With well trained operators even this is not a problem, if it is done with adequate care. It is absolutely essential that one or two of the mine personnel is fully trained and conversant in the operation of the system, so that they are capable of identifying and accurately reporting the problem and its symptoms. If necessary a longer training period may prove beneficial to overcome this problem.

At Westar Mine a number of changes and adjustments were made, many of which were carried out under the direction of Conspec via the telephone. Many of these adjustments were not necessary,and could have been avoided by providing adequate training to the mine personnel.

e) Sensor calibration.

As indicated above, frequent adjustment of the system could prove more problematic than productive. In the case of Westar, it is believed that this was probably done inadvertantly in an attempt to rationalize the readings.

It appears that the sensors were subjected to an unduly high relocation within the mine in a short time span. They were frequently removed and calibrated, and re-calibrated because of the suspicion that they were producing erratic readings. Such practice could result in a significant shortening of the life of the sensors. This is caused by increased exposure of the sensors to the fairly high span gas concentrations. Also the increased handling of the sensors, increases the risk of damage due to shock and vibration, as well as an increased probability of getting it into contact with chemicals capable of poisoning the sensor head (or cell).

f) Lastly, it is suspected that at some point in time the system was significantly tampered with, as reported by Westar. If this is true, this is a very unfortunate situation by any standard. It definitely does not provide a suitable environment for the successful operation of any system.

Since this is a relatively new technology being introduced into the coal mines, the need for an interest and motivation is considered absolutely essential for satisfactory peformance.

## RECOMMENDATIONS

1. Provide training for the mine personnel in the use of the system. This training is to include not only system operation procedures, but also to provide instruction on the methods and procedures for problem identification (ie. use of diagnostic procedures).

2. The mine management must be sufficiently motivated to keep the system operational. This is generally true when the data being provided is critical to the mine's operation.

For the present system this is rather difficult to generate since it monitors only the environment. When this type of system is installed by Canmet in a mine, there is a high probability that it may not be enthusiastically received, since it readily makes available to all mine employees, the environmental information in details. Any error or incorrect reading because of system malfunction or otherwise could cause serious misunderstanding between management and underground workers.

It is strongly recommended that the Senturion 200 system be used for both monitoring and control of production so that the full potential of the system is better understood and appreciated. This will no doubt generate greater interest both for management and engineering personnel.

In conclusion it should be noted that these recomendations merely provide the correct environment for the succesful operation of any system. The system itself however has to have the necessary capabilities and the reliability to provide the correct information. The author is of the opinion that the system in its present state at Westar is both capable and reliable enough to provide the necessary data. Occasional component failures are inevitable. It is essential that mines which use this or any such systems should have adequate spares available on site.

Conspec will make all efforts to include recommendations for spares if the customer needs are explained in advance.

## FUTURE DIRECTIONS FOR CONSPEC

From the evaluation of the system at Westar, it was apparent that the components which were problematic can be summarized as below:

i. The Communication Modem Adjustment.
ii. The J-Tec Air-flow monitors.
iii. The J-Tec Methanometers.
and iv. Sensor calibration and handling.

As a result, Conspec is presently opting for the use of direct accessor trunk communication paths from the central station in all systems being presently marketted. This requires the use of Remote Trunk "Extender" stations, rather than Remote Modem Trunk Driver stations. The stations are identical except that the modem is not used.

Use of this technique requires an additional power supply and trunk driver station at the central processor location. An additional pair of wires is also required for communication. The major advantage is that absolutely no adjustments are required.

Because of the problems experienced with the J-Tec sensors, Conspec had to modify their designs to make them functional with the system. These modified units will be used on current systems. However, for the long term Conspec has set in motion plans to refine these instruments for use on the system. To date Conspec has already negotiated an agreement with J-Tec to purchase the transducer elements (sensor heads) for the air-flow and methane sensors.

This will allow Conspec to build its own instruments, allowing a better degree of control on the quality and reliability of the instruments. It is further intended to fine-tune the sensor electronics, as well as to simplify the necessary calibration procedures for the instruments.

Presently the sensors require on the spot manual adjustment of the sensor electronics during calibration using span gas. This appears to be causing unstable performance of the sensor units. Conspec is planning to introduce a self calibrating electronic device to eliminate such manual corrections and consequent problems. This will ultimately reduce the need for manual calibration to no more than two or three times each year.

## ACKNOWLEDGEMENTS

The author would like to thank the mine personnel at Westar and at the CANMET Coal Research Laboratory (Calgary), for their co-operation and assistance during the investigation and preparation of this report.

APPENDIX "A"

14SQ.23440-4-9141
0SQ84-00264

## STATEMENT OF WORK

1. The Contractor shall make a site visit to the CONSPEC system installation at the mines of Westar Resources at Sparwood, B.C.

2. During the site visit, the Contractor shall make a complete system inspection and review, including but not limited to surface and underground installations; data collection, transmission, compilation and output; and complete tests of operational performance of all aspects of the system, including software.

3. The Contractor shall diagnose any system malfunctions under current or reasonably anticipated coal mine operational conditions and make such corrections (including software) as can reasonably be done during the course of this visit. Such corrections as cannot be performed during this visit shall be identified and have recommended corrective actions described.

4. The Contractor shall train Westar and CANMET personnel in the installation, operation and routine maintenance of the system, both hardware and software.

5. The Contractor shall prepare a report detailing the work done under this contract, including all significant findings of the site inspection and system review and recommendations for system correction, upgrading and maintenance. This report shall be comprehensive to include the full history of this system installation and problems, to serve as a partial guide to others for future similar installations.

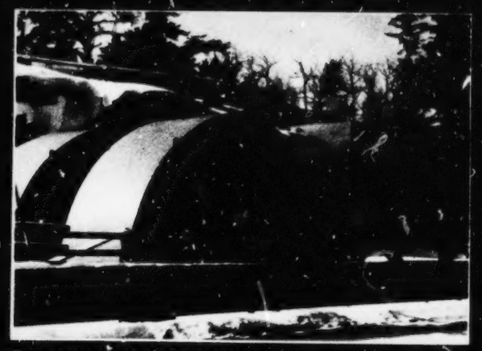
6. The Contractor shall be represented by Mr. M. Mohamed, their Senior Design Engineer for all work in this contract, as per discussion with CANMET on October 19, 1984.

7. This work is to be done as quickly as can be arranged. The site visit is to take place in October or November 1984, and the final report to be submitted in draft form to the Scientific Authority by December 31, 1984.

8. The Contractor shall not travel to the site until advised to do so in writing (or by telex) by the Scientific Authority, who shall be responsible for arranging the site work with Westar.

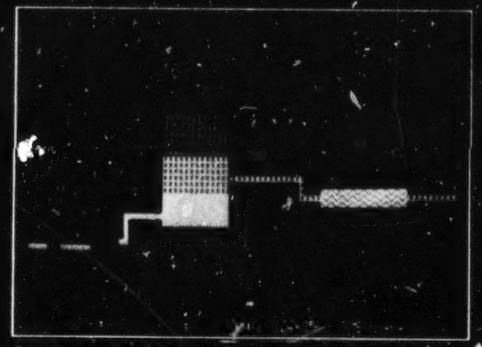
# conspec

Control Monitoring and
Mine Management Systems



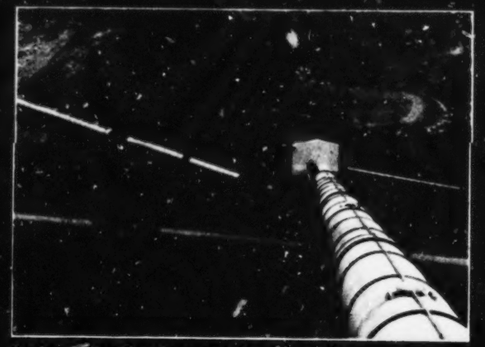
Environmental Control

A wide range of instruments are available to provide continuous environmental monitoring. The system detects fire, improper ventilation and hazardous conditions - protecting equipment and personnel. All components are intrinsically safe and can be used under explosive or corrosive conditions.



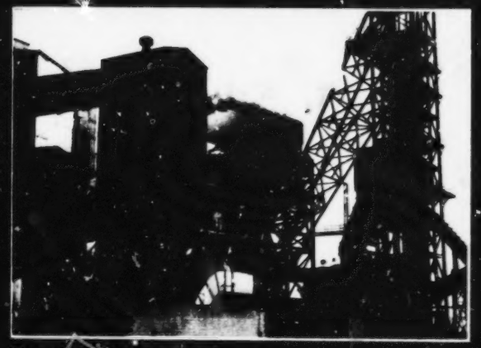
Color Graphic Display

Enhances the operator's understanding of the operation, improving maintenance and management reporting.



Automatic Equipment Sequencing

Command Programming synchronizes equipment operation for maximum efficiency.



Energy Management

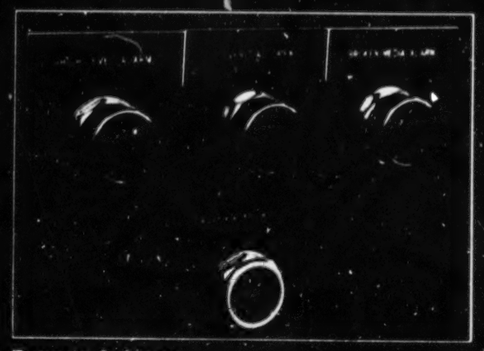
Scheduling of electrical loads - reducing demand peaks and power consumption within the plant or mine.

## Cost Management

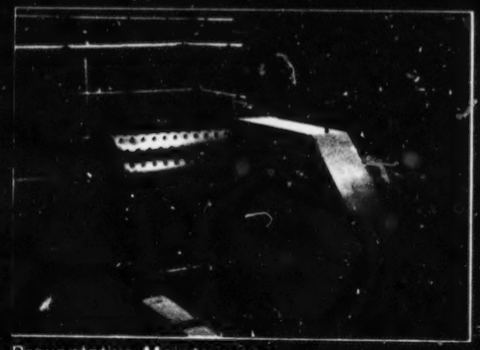
In order to remain competitive, more and more plants and mines are turning towards automation to maximize productivity. Through management of each individual aspect of the operation, the sum of all amounts saved can be translated into tremendous dollar value.

Trouble Shooting

An automatic trouble shooting routine isolates equipment failures for speedy maintenance, reducing downtime.



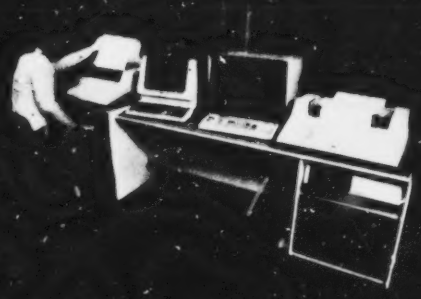
Reports & Alarms



Preventative Maintenance

Equipment Control Monitoring

The Series 200 system Controls and Monitors each stage of operations, equipment and manpower.



## The System

Designed by Conspec, the Senturion 200 is a unique supervisory command center, overseeing the operation of systems and equipment within mines and plants. By managing your entire operation, the Senturion 200 attempts to gain maximum efficiency, per hour, per person - a worthwhile investment for future growth.

While the Senturion 200 boasts the latest in computer technology, no computer expertise is required by plant personnel to program or operate the system. Information is provided in a form that is easy to understand, enabling spontaneous reaction through a simple keyboard. As well, many of the automatic features available reduce the need for operator involvement. And because the Senturion 200 is totally modular, all systems are flexible and expandible - capable of meeting the changing needs of your operations.

The Senturion 200 - inexpensive, reliable, safe and easy to install - a total Control, Monitoring and Management system. It is designed to increase production, lower costs and improve the safety conditions resulting in a more profitable operation.

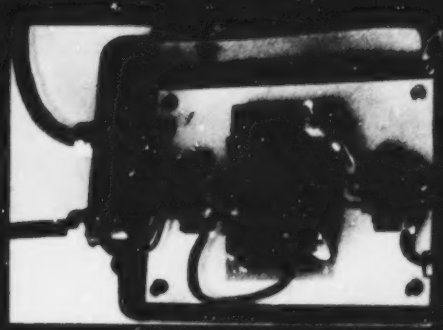
## Accessor® Trunk Cable

Varying in length to suit the distance required the compact four wire trunk cable measuring less than ½" in diameter provides both power and communication from the central command computer to 'accessors' and remote sensors placed throughout the area being monitored or controlled.

# The Accessor ®

Unlike other systems which require a number of field cabinets and a bulky amount of cabling to transmit information, the Senturion 200 uses a small 'Accessor' placed beside each piece of equipment along the Accessor Trunk Cable. By installing the Accessor directly beside the equipment or operation being Controlled and Monitored, some basic and important advantages are presented:

1) Substantial reduction of wiring and installation costs,
2) Standardization of hardware,
3) Ease of additional future points,
4) Need for local power source eliminated,
5) Allows stocking of standard replacement parts.



## Operating Routines

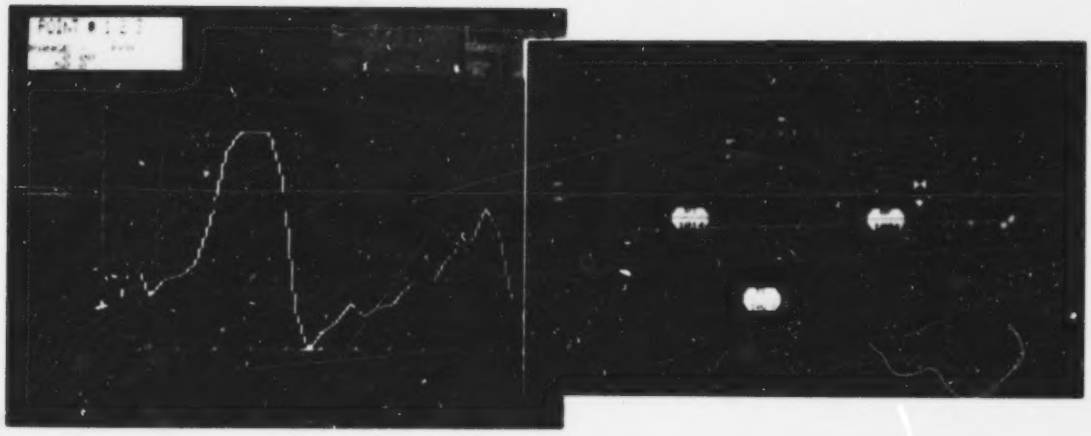
Operation of the Senturion 200 is simple and straight forward. The system allows the user at the command center to implement the automation, control and monitoring of equipment as needed. The following lists some of the operating routines carried out by the Senturion 200:

- English language keyboarding eliminates the need for computer-skilled personnel in the programming and operation of the system,
- Monitoring and Alarm identification provided for all operating equipment,
- Supplies immediate information on the equipment status, quickly pinpointing fault conditions,
- Provides automatic warning to remote work sites,
- Allows for centralized control of equipment and overriding of local controls,
- Provides automatic sequential start-up and shut down of equipment,
- Produces Status, Alarm, Shift and Production Reports as well as Trend Logs and Color Graphics action displays,
- Generates automatic preventative maintenance work orders for equipment,

| | | | | | |
|---|---|---|---|---|---|
| 05:12:31 | 510 | COMP. AIR SUPPLY | LOW | ALARM | 96.0 PSI |
| 06:51:28 | 103 | 86 PUMP BRG TEMP | HIGH | ALARM | 138 DEG.F |
| 08:48:51 | 531 | E CONV. TORK BELT | | ALARM | |
| 08:48:51 | 121 | E CONV. DRIVE | OFF | ALARM | |
| 08:48:55 | 120 | E CONV. SEQ SWITCH | | ALARM | |
| 08:48:56 | 224 | 81 PANEL CONV. DRIVE | OFF | ALARM | |
| 08:48:56 | 256 | 82 PANEL CONV. DRIVE | OFF | ALARM | |
| 08:48:57 | 274 | 84 PANEL CONV. DRIVE | OFF | ALARM | |
| 08:48:59 | 229 | 81 PANEL SEQ SWITCH | | ALARM | |
| 08:49:00 | 258 | 82 PANEL SEQ SWITCH | | ALARM | |
| 08:49:01 | 277 | 84 PANEL SEQ SWITCH | | ALARM | |
| 08:55:22 | 121 | ON COMMD EXEC | | | |
| 08:55:22 | 121 | E CONV. DRIVE | ON | NORMAL | |
| 08:59:56 | 274 | ON COMMD EXEC | | | |
| 08:59:56 | 274 | 84 PANEL CONV. DRIVE | ON | NORMAL | |
| 09:02:19 | 256 | ON COMMD EXEC | | | |
| 09:02:19 | 256 | 82 PANEL CONV. DRIVE | ON | NORMAL | |
| 09:04:28 | 224 | ON COMMD EXEC | | | |
| 09:04:28 | 224 | 81 PANEL CONV. DRIVE | ON | NORMAL | |
| 10:05:09 | 612 | WATER TANK LEVEL | HIGH | ALARM | 17.5 FEET |

TYPICAL EVENT PRINT OUT

- Displays supervisory instructions, detailing how the operator should respond to alarm conditions,
- Delivers color plotting of Analog Values,
- Monthly Statistical Analysis Reports detailing important aspects of equipment failures,
- Offers computer modelling of the ventilation system with real time entry of ventilation variables,
- Future forecasting the possible progression of fires and other environmental developments.



## Color Graphics Display

This simulated visual aid allows the operator to evaluate and analyse plant or mine operations with ease. Should the operator require a closer "view", the Color Graphics Display can enlarge a particular section providing close up shots. Up to 1000 graphics can be displayed and logged for future reference.

Controls loading on Conveyors and other equipment to **maximize output**

**Synchronizes equipment**

**Reduces downtime** on equipment by quickly identifying faults

**Preventative Maintenance Scheduling** on all electrical/ hydraulic equipment

## Increases Production

Monthly failure **Summary Report**

## SENTURION 200

## Improves Safety Conditions

## Lowers Costs

**Reduces** potential risk of employee **injury** through detection of dangerous conditions

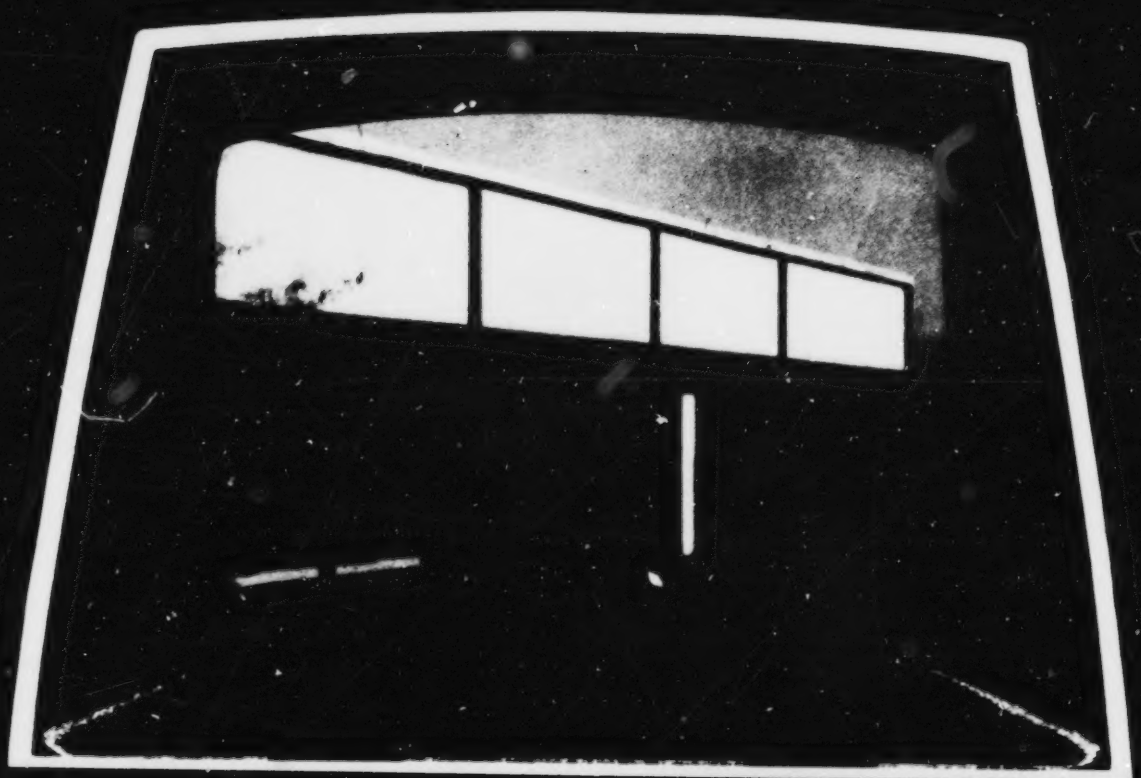
Environmental Control/Monitoring **minimizes ventilation costs**

Reduces risk of lawsuits, legal investigations, and **lowers insurance premiums**

Control/Monitoring system is **intrinsically safe** including operation under explosive and corrosive conditions

Reduces damage to equipment by **identifying the problem** before it becomes a major expense

**Saves on utility bills** by reducing 'Load Peaking'



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